

Research

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New Damage Model Benefits Assessment of Existing, Future Airfield Pavements

A University of California (Los Angeles) professor has developed an advanced, thermomechanical damage model to assess the quality of both existing and new types of airfield pavements. Prof. Jiann-Wen Woody Ju's new analytical and numerical method provides a predictive capability:

- to evaluate potential alternative materials without large-scale field experiments, and
- to determine the remaining useful life of concrete airfield pavements.

Many modern aircraft subject airfield pavements to combined stresses caused by high-temperature exhaust gasses from vectored-thrust engines and auxiliary power units (APUs), JP-8 jet fuel, and high-pressure wheel loadings. These factors cause the pavement to undergo very rapid, intense heating and cooling cycles combined with chemical and wheel-stress loads. The B-1, A-10, AV-8B, F/A-18, the proposed F-22, and the future Joint Strike Fighter typify aircraft that can or could produce these thermo-mechanical loads. The resulting concrete pavement damage is severe and appears as large spalls, cracking, and weakened areas.

With this new understanding, the Air Force could potentially save hundreds of millions of dollars in the beddown of the new aircraft and prevent engine damage caused by foreign object debris.

For a technical description:

<http://www.cce.ucla.edu/faculty/woody.htm>

Major Michael Chipley, Ph.D.
Directorate of Aerospace and Materials
Sciences
(202) 767-0468, DSN 297-0468

AFOSR INVESTIGATOR RECEIVES HUBER AWARD, TOP CIVIL ENGINEERING ACCOLADE

Dr. Jiann-Wen Woody Ju has received the 1997 American Society of Civil Engineers (ASCE) Walter L. Huber Award, considered the mid-career achievement award for academic professors who have made notable achievements in civil engineering and research applications. ASCE's Mechanics Division nominated Dr. Ju as one of 20 ASCE division finalists. The ASCE singled out Dr. Ju and his research on the elastoplastic continuum and micromechanical damage models.



Professor Ju

In addition, in February 1998, the American Society of Mechanical Engineers (ASME) elected Professor Ju as an ASME Fellow, becoming one of the youngest members of the society. Professor Ju is recognized for his contributions in damage mechanics, plasticity, and mechanics of composites.

For more information, ASCE maintains a website at:

<http://www.asce.org/aboutasce/allabout.html>

The ASME website is located at:

<http://www.asme.org>

Photo courtesy of:
Naval Facilities Engineering
Service Center



A large crater in the Y/A-18 parking apron at Hurler Field, FL, was caused by a hot, vectored exhaust gas. AFOSR-supported research provides a way to predict how hot, vectored exhaust gasses damage airfield pavements.

Protein Identified that Protects Against Toxicity

University of Arizona researchers have discovered that a simple mammalian protein — called Substance P (SP) — may protect humans from lung damage caused by JP-8 jet fuel aerosol. The protective benefit also occurs even if SP is administered after exposure. This simple protein — a neuropeptide — shows promise for developing protective agents for warfighters. The discovery has also triggered studies on SP's anti-AIDS and anticancer potential.

Using a synthetic analog of SP, Dr. Mark Witten observed that an aerosol application of the substance offered complete protection for mice against JP-8-induced injury. SP protected the mice even if it was administered after they were exposed to the fuel aerosol. In another experiment, set up to confirm SP's role in protecting the lung, the researchers exposed mice to the same fuel aerosol but then chemically blocked SP activity in the lung. This action exacerbated the tissue damage — leaky lungs and impaired breathing function — and thus confirmed SP's protective role.

In a similar experimental approach, Dr. David Harris studied SP's affect on JP-8-induced changes to the immune system in mice. JP-8 can reduce organ weights and the number of immune cells, can alter immune cell populations, and can cause functional changes in the immune system.

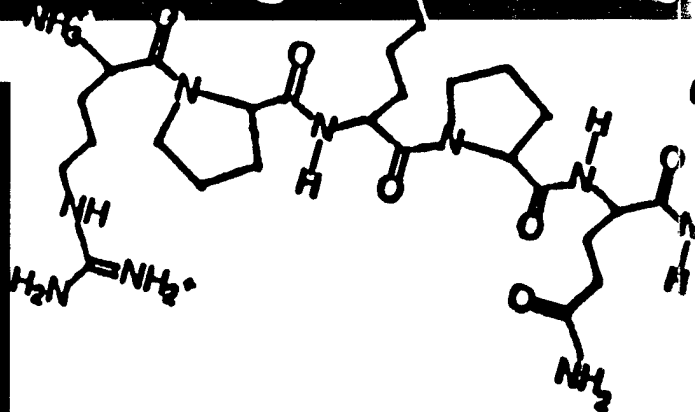
Dr. Harris found that SP treatment shielded immune cells from jet fuel-induced reductions in both their number and function. This, in turn, triggered trial



Dr. Mark Witten



Dr. David Harris

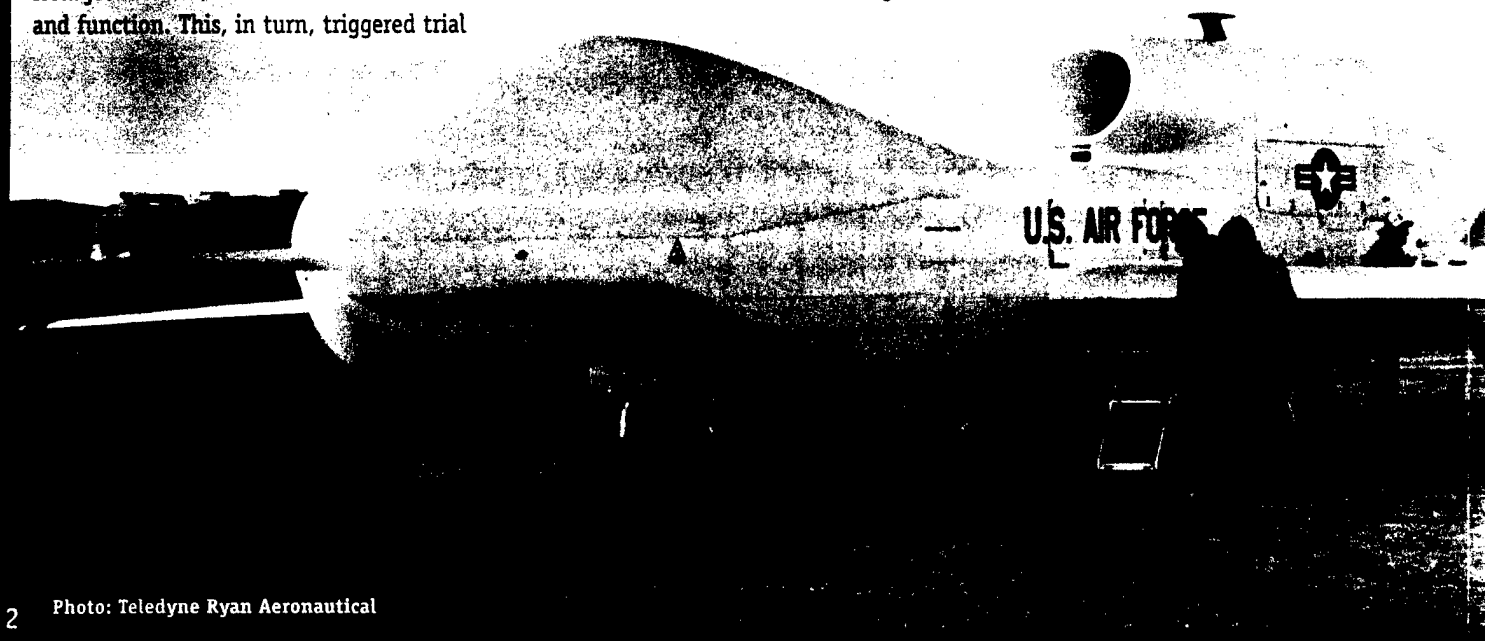


Toxicology studies reveal:

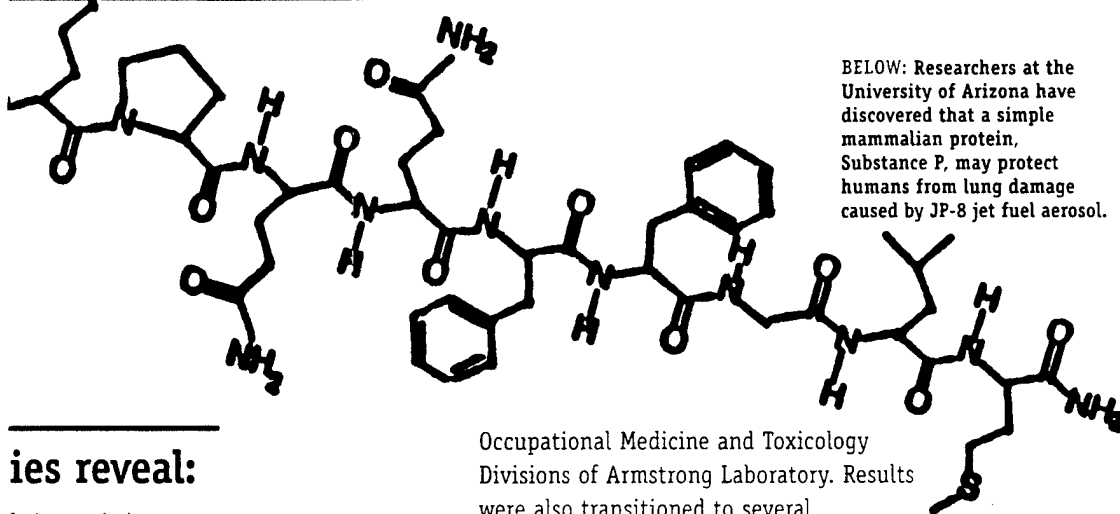
- effective treatment of tissue injury due to JP-8 jet fuel exposure
- potential treatments for warfighters exposed to biological and chemical stressors
- potential anti-AIDS and anticancer treatments

studies to examine the potential anti-AIDS and anticancer effects of SP. In these studies, SP actually delayed the onset of viral effects and reduced the spread and growth of cancer cells in mice.

Drs. Witten and Harris have patented the use of SP as an inhalation aerosol therapy. For health risk assessment purposes, study results were transitioned to the Air Force Surgeon General and to the



Inst Toxicity of Jet Fuel



BELOW: Researchers at the University of Arizona have discovered that a simple mammalian protein, Substance P, may protect humans from lung damage caused by JP-8 jet fuel aerosol.

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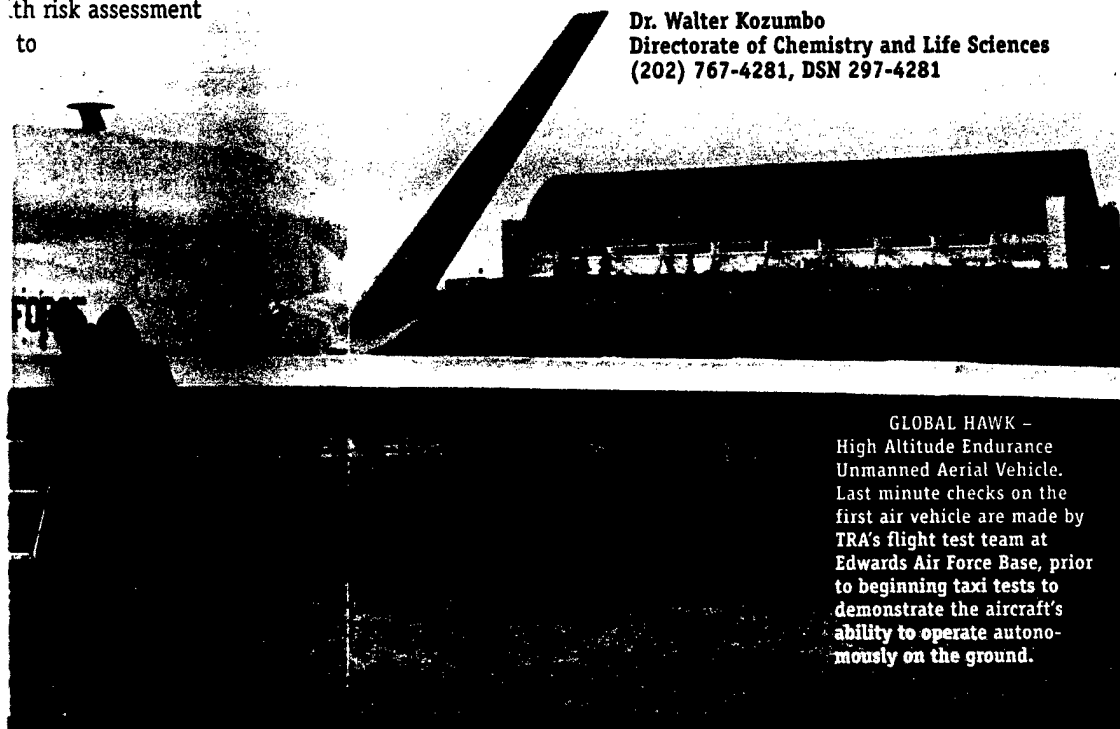
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Occupational Medicine and Toxicology Divisions of Armstrong Laboratory. Results were also transitioned to several pharmaceutical companies interested in this technology for its potential to stimulate the immune system and to enhance the effectiveness of vaccines. They are currently negotiating rights for its further development.

The SP research will also help explain how chemicals and mixtures of chemicals can damage human tissue. Understanding this mechanism may be of value in identifying specific, tissue-damaging chemicals within JP-8 which could aid in designing safer new fuels. JP-8 is the standard jet fuel for the Air Force, Army, Air National Guard, and NATO. It is used to operate their tanks, to warm their tents, and to cook their food. It is also almost entirely composed of (and thus nearly identical to) the basic commercial jet fuel formulation, Jet-A. The Navy's jet fuel, JP-5, is also very similar to JP-8.

Dr. Walter Kozumbo
Directorate of Chemistry and Life Sciences
(202) 767-4281, DSN 297-4281



GLOBAL HAWK -
High Altitude Endurance
Unmanned Aerial Vehicle.
Last minute checks on the first air vehicle are made by TRA's flight test team at Edwards Air Force Base, prior to beginning taxi tests to demonstrate the aircraft's ability to operate autonomously on the ground.

New U.S. Air Force, European Pat

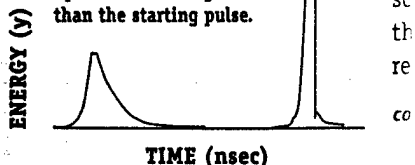
Air Force Engineer and Exchange Program Leads Compact, Powerful Laser

Dr. Jerry Franck, an Air Force optical physicist and manager of AFOSR's international program, has patented a new type of powerful, compact laser. Mr. Wolfgang Riede, a German physicist, has developed the laser's inherent simplicity makes it robust in design and use, making it very suitable to withstand the rigors of hard field use. Because the laser is less complex and less costly than other military lasers of similar power, it is a strong candidate for use in target designators, illuminators, and range finders. Medical laser applications could also benefit.

As a participant in the Air Force Engineer and Scientist Exchange Program (ESEP), Dr. Franck was assigned to the Institut für Technische Physik within the Deutsche Forschungsanstalt für Luftfahrt (DLR) in Stuttgart, a German research organization similar to NASA. Dr. Franck was assigned to research in the area of phase conjugate optics, a research area of interest for a variety of ranging and tracking applications, and coherent communications for building high-power laser systems. During his assignment, Dr. Franck observed that a small, portable type laser suddenly delivered an unexpected power of more than 1 gigawatt, (a thou

During the test, the laser target played a role. However, the laser was somewhat misaligned. Riede, physicist, and power

BELOW: Two pulses from a standard solid-state laser. The pulse on the left is the beginning pulse. On the right is the amplified pulse compressed using stimulated Brillouin scattering (SBS) and bulk plasma switching. The peak power of the compressed pulse can be up to six times higher than the starting pulse.



New U.S. Air Force, European Patents

Air Force Engineer and Scientist Exchange Program Leads to Compact, Powerful Laser

Dr. Jerry Franck, an Air Force optical physicist and now manager of AFOSR's international programs, has developed and patented a new type of powerful, compact laser with Mr. Wolfgang Riede, a German physicist and colleague. The laser's inherent simplicity makes it robust and more rugged in design and use, making it very suitable to withstand the rigors of hard field use. Because the laser is less complex and less costly than other military lasers of similar power, it is a strong candidate for use in target designators, illuminators, and range finders. Medical laser applications could also benefit.

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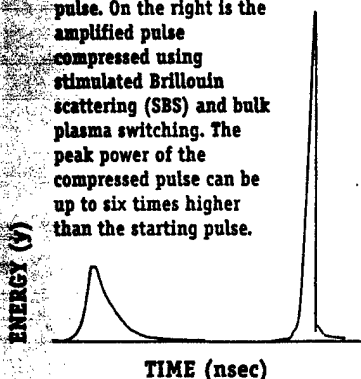
Dr. Franck and Mr. Riede discovered that focusing laser energy into a test cell containing nonlinear optical materials produces a dynamic mirror. Through a process termed stimulated Brillouin scattering, or SBS, the dynamic mirror returns energy back

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During the Gulf War, the effectiveness of laser target designators and illuminators played a major role in military operations. However, these devices tend to be somewhat large and sensitive to optical alignment. The Variable Pulse Length Laser, developed by Dr. Franck and Mr. Riede, provides an inexpensive, rugged, and powerful alternative.

BELOW: Two pulses from a standard solid-state laser. The pulse on the left is the beginning pulse. On the right is the amplified pulse compressed using stimulated Brillouin scattering (SBS) and bulk plasma switching. The peak power of the compressed pulse can be up to six times higher than the starting pulse.



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Technology

Transition

Spotlight

(Each issue, RH will highlight a recent technology transition that benefits Air Force operations.)

- Customer** Air Combat Command (ACC) adopted a research simulator in January to support training for operators of Predator Uninhabited Air Vehicles (UAVs).
- Benefit** The research simulator provides ACC with its first dedicated training capability for both individuals and teams controlling UAV assets.
- Basic Research** ... Research simulators were used to conduct university, industry, and government laboratory research on human performance. Research simulators and embedded task scenarios provided researchers with new capabilities for multi-disciplinary research that combines disciplines of cognitive process modeling, human interface, training, team communication, and physiology.
- Performer** A research team led by Dr. Elizabeth Martin, of the Warfighter Training Research Division, in Mesa, Ariz., assembled the apparatus for research simulation of UAV tasks. The Division is part of AFRL's Human Effectiveness Directorate. AFOSR program manager: Dr. John Tangney, Directorate of Chemistry and Life Sciences, (202) 767-8075, DSN 297-8075.



Research Highlights

Air Force Office of Scientific Research
Communications and Technical Information
110 Duncan Avenue, Room B115
Bolling AFB, D.C. 20332-8050

Director: Dr. Joseph F. Janni

Web site: www.afosr.af.mil

DSN 297-2353 or 297-4964

Comm: 202-767-2353 or 202-767-4964

Fax: 202-767-5012

e-mail: jane.knowlton@afosr.af.mil

Editor: Jane Knowlton

Writer: Greg McKinney

Research Highlights is published every two months by the Air Force Office of Scientific Research. This newsletter provides brief descriptions of AFOSR basic research activities including topics such as research accomplishments, examples of technology transitions and technology transfer, notable peer recognition awards and honors, and other research program achievements. The purpose is to provide Air Force, DoD, government, industry and university communities with brief accounts to illustrate AFOSR support of the Air Force mission. *Research Highlights* is available on-line at:

<http://www.afosr.af.mil>

To access our web-site, click on the Research Products and Publications icon, then on *Research Highlights*.

New U.S. Air Force, European Patents (continued)

to the source. This in combination with bulk plasma switching — a term the researchers coined to describe laser-induced breakdown within the cell — compresses and truncates the resulting return pulse by as much as a factor of ten. The return pulse re-enters the laser, is amplified, and then sent back to the cell. This begins the process again, producing increasingly shortened pulses.

The U.S. Air Force has received its patent. The DLR's patent is pending with the European Community (Germany, France, United Kingdom.) The laser's U.S. patent Serial Number is 5,648,976. For more information on licensing the patent, contact Dr. Franck. For more technical information, see our website at:

<http://www.afosr.af.mil>



Engineer Scientist and Exchange Program (ESEP)

The DoD Engineer and Scientist Exchange Program (ESEP) supports science and technology through international cooperation in military research, development, and acquisition through the exchange of defense scientists and engineers. ESEP provides on-site assignments for U.S. military and civilian scientists and engineers (S&Es) in foreign government organizations and reciprocal assignments of foreign S&Es in U.S. government organizations. ESEP supports current USAF S&T requirements by targeting specific foreign technologies. It provides insight into the technology and project management techniques of foreign laboratories and centers, opens new areas of possible technical cooperation, and attempts to eliminate duplication of technical efforts among allied and friendly nations.

Dr. Jerry Franck
Directorate of Academic and International Affairs
(202) 767-4970, DSN 297-4970



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Communications and Technical Information

110 Duncan Avenue, Room B115

Bolling AFB, D.C. 20332-8050